Mid-Atlantic Universities Transportation Center
Program Progress Performance Report
January 1 – June 30, 2012

INTRODUCTION

The Mid-Atlantic Universities Transportation Center (MAUTC) is comprised of six universities—Morgan State University, The Pennsylvania State University (Penn State)(lead),University of Maryland, University of Virginia, Virginia Polytechnic and State University (Virginia Tech), and West Virginia University—and is located in Federal Region 3. MAUTC has served as the Region 3 regional UTC since the program's inception in 1987.

In the past, MAUTC primarily served as a conduit of research funding for its member institutions. Each institution conducted its own program of activities—research, education, and technology transfer—to respond to the priorities of the U.S. Department of Transportation's strategic goals as well as the institutions' state departments of transportation, which were the primary sources of matching funds, and other in-state stakeholders.

Under the current grant, MAUTC is organized as a single entity serving multiple, non-university stakeholders who are part of the transportation enterprise of the mid-Atlantic region. Each member institution received $300,000 (base funds) to be used for any purpose eligible under the grant, including research, student support, workforce development, technology transfer and administrative costs. The remaining funds will be distributed, through a competitive proposal process, among the following programmatic areas:

Pooled Research Funds ($750,000)

Under the previous grant, DTRT07-G-0003, MAUTC began to move toward a more collaborative approach for conducting research. A portion of Penn State's funds was escrowed for pooled research projects to encourage member institutions to conduct joint research that would address regional transportation issues. Each member institution participated in at least one regional proposal.

The pooled research program will build on the success of the earlier "regional program."Advanced or applied research that is performed by multiple universities or funded by multiple sponsors will be eligible for funding. Any combination of universities and public and/or private matching funds are eligible. Public sector stakeholders, i.e. the Region 3 state DOTs, are given the right of first refusal for use of the federal funds in this program area. Proposals will be solicited quarterly by the MAUTC Project Selection Committee, comprised of representatives of each of the MAUTC universities and from the DOTs in the states that are home to the MAUTC universities.

Workforce Development/Student Support ($300,000)

Developing the next generation of transportation professionals is a critical component of MAUTC's mission. Each member institution may submit a proposal to provide direct support to university students, graduate or undergraduate, or to fund activities that encourage pre-college or pre-engineering college students, especially those from underrepresented or disadvantaged groups, to students in science, technology, engineering, and mathematics (STEM) fields and consider transportation a career, improve the content knowledge and professional skills of the STEM teacher workforce, or improve the transportation-related resources available for learning STEM subjects.
Workforce Development/Professional Development ($200,000)

The development of tomorrow's transportation workforce is critical to maintain and improve the safety and efficiency of our transportation system. As much as 50 percent of the transportation workforce is due to retire in the next several years, which will create a large knowledge gap that must be filled.

These funds are available for activities that will help to further develop the knowledge, skills, and abilities of the transportation professionals for both personal development and career advancement. Activities may include, but are not limited to, on-site or distance education in the form of conferences, short courses, webinars, seminar series, tutorials, communities of practice, individual consultation, and technical assistance.

Implementation and Tech Transfer ($200,000)

Publications and presentations are the standard method by which faculty, researchers and students disseminate the knowledge garnered through their research. In addition, MAUTC will use social networking sites such as Facebook, LinkedIn, and Twitter to communicate research activities and findings.

These funds will be available to help fund conferences, workshops, webinars, etc. to further the adoption of new-to-the-user products or procedures by the transportation community.

ACCOMPLISHMENTS

Penn State has issued subcontracts to each member institution for their base funds.

The MAUTC website has been updated with the current directory of personnel. In addition, an "Ask the Expert" link has been added where visitors to the website can submit a technical question and have it answered by a knowledgeable faculty member or researcher from any of the Center members. MAUTC Facebook and LinkedIn pages have been created; content is being developed.

Processes, forms and templates have been created for proposal submission and evaluation. Proposals for the pooled funds were solicited for the first quarter. One research proposal involving three universities was submitted. The Project Selection Committee met via conference call to discuss the merits of the research. After a lengthy discussion, the research team withdrew the proposal to revise and resubmit it for the second quarter proposal review in June.

Seven research proposals, three professional development proposals, and two implementation proposals were submitted in the second round of Pooled Fund request for proposals. Four research proposals were funded.

Pooled Research Projects:

- A Modified Capacitated Arc Routing Problem (MCARP) for the Resource Effectiveness of Highway Infrastructure Inspection and Scheduling (IIS) – **MSU** (lead) and UMD

  Highway infrastructure elements, such as pavements, bridges, tunnels, and other roadside assets perform major functions in the utilization and overall safety of highways throughout their life-cycle. As a consequence, their maintenance is very critical to maximize life of the highways and promote safe mobility. However, budget and personnel constraints make it difficult for Departments of Transportation (DOTs) and other local government authorities to meet highway

maintenance inspection and maintenance scheduling challenges. As a result, they must prioritize as well as maximize the use of manpower to keep pace with the inspection and scheduling demands of their highway assets to maintain acceptable service levels. In this project, a Modified Capacitated Arc Routing Problem is introduced for maximizing the resource effectiveness for Highway Infrastructure Inspection and Scheduling (IIS). Various case studies and sensitivity analysis will be conducted to validate and calibrate the developed model using data from the Baltimore Department of Transportation. The findings of the project are expected to result in significant cost savings for DOTs for undertaking IIS activities in an optimal manner that will ensure acceptable service levels of highway assets.

- Modeling the Dynamics of Driver's Dilemma Zone Perception Using Machine Learning Methods for Safer Intersection Control – **VT** (lead), MSU and Penn State

  Rural, high-speed signalized intersections are associated with vehicle crashes due to dilemma zone problems. Dilemma zones (DZ) are defined in either time or space, as zones where some drivers may decide to proceed, and some may decide to stop at the onset of yellow. This disagreement among drivers can lead to rear-end crashes (when a driver decides to stop while their follower decides to proceed) and/or right-angle crashes (when drivers end up violating the red light and crash with side street traffic).

  Researchers at Virginia Tech, Morgan State University, and Penn State will investigate the dynamic nature of driver's perception of dilemma zones, and whether that perception changes as a function of their experience driving through safe or unsafe intersections. A matching project funded by the Virginia Center for Transportation Innovation and Research (VCTIR) is investigating different control methods to minimize dilemma-zone-related crashes, ranging from traditional advance detector and actuated control optimal configuration to the use of advanced technologies such as Wavetronix, Detection-control systems, etc. These two efforts can lead to better modeling of driver perception, better control algorithms, and ultimately safer intersections.

- Using Mobile Probes to Inform and Measure the Effectiveness of Macroscopic Traffic Control Strategies on Urban Networks – **Penn State** (lead) and VT

  Urban traffic congestion is a problem that plagues many cities in the United States. Devising and testing strategies to alleviate this congestion is especially challenging due to the difficulty of modeling these complex urban traffic networks. However, recent work has shown that these complicated systems can be modeled in relatively simple ways by leveraging consistent relationships that exist between network-wide averages of pertinent traffic properties, such as average network flow, network density, and the rate at which trips are completed. Using these "macroscopic" traffic models, various control strategies can be developed to mitigate congestion and improve network performance. However, the effectiveness of many of these strategies depends on the ability to estimate traffic conditions on the network in real time.

  Researchers will investigate how real-time mobile vehicle probes can be combined with macroscopic urban traffic models to implement more efficient network-wide traffic control strategies. Additionally, the researchers will examine how the effectiveness of these strategies can be directly measured in the field using only mobile vehicle probe data. The research may lead to more efficient control of urban traffic networks and a reduction in vehicular delays during rush hours.

- Structural Health Monitoring to Determine Long-term Behavior of AFRP Composite Bars in Prestressed Concrete Panels for Field Deployment – **MSU** (lead) and UVA

  Corrosion-induced deterioration of steel rebar in concrete structures often demands costly repair and maintenance when the steel rebar swells, resulting in cracks, spallings, and openings that increase its susceptibility to corrosion. Previous research by the principal investigator has shown the validity, deformability, and suitability of aramid fiber-reinforced polymer (AFRP) bars used in pre-stressed, precast concrete deck panels (PCPs). However, research is still needed to monitor and assess the long-term behavior of AFRP bars due to creep, shrinkage, and pre-stress losses when exposed to thermal and sustained loads similar to "in-situ" bridge conditions. The research will be divided into two phases: (1) a laboratory-scale investigation for accelerated degradation and time-dependent behavior and (2) a full-scale investigation for long-term performance evaluation under natural environmental conditions. Phase I will examine effects of freeze-thaw, creep, and shrinkage effects whereas Phase II will focus on constructing two full-scale PCPs: one with conventional pre-stressing steel and the other pre-stressed with AFRP bars that will be continuously monitored outdoors. For both phases, instrumentation (internal and external measures) will be deployed for measuring strain response of the specimens. Where appropriate, the investigators will deploy state-of-the-art digital imaging correlation (DIC), a non-contact optical-based deformation measurement technique, for monitoring specimen behavior. This study will also serve as a test bed for deploying DIC for performance monitoring of concrete structure and finite element analysis (FEA) to numerically compare system performance to conventional designs.

Implementation Proposals

Two of the pooled research proposals, *Modeling the Dynamics of Drivers' Dilemma Zone Perception Using Machine Learning Methods for Safer Intersection Control* and *Using Mobile Probes to Inform and Measure the Effectiveness of Macroscopic Traffic Control Strategies on Urban Networks*, included a request for implementation funds to develop conferences to disseminate the findings of the research. Both of these implementation proposals were funded.

Professional Development Proposals

One of the three professional development proposals was awarded funding.

<u>Conference on Agent-Based Modeling in Transportation Planning and Operations</u>

In the past two decades, transportation professionals and researchers have been incorporating individual person characteristics as a collection of autonomous decision-making entities called agents in modeling, on the planning side, the traveler daily activities in terms of route choice, mode choice, trip chaining, trip substitution, early or late departures; in evacuation planning and emergency management; and in the traveler willingness to use toll roads/HOT lanes. On the operations side, several researches are introducing individual traveler characteristics called agents in modeling the acceleration and braking behaviors of drivers, their car-following and lane-changing maneuvers, and in particular, aggressive driving that is leading to car manufacturers' adoption of eco-driving, to name a few approaches.

Agent-based modeling allows the researchers and users to keep the personal traveler identity or a collection of them as agents intact through the modeling process and consequently allow the users to trace and make use of the agents' characteristics in their planning and operations of transportation facilities. In contrast to aggregate-based modeling, agent-based modeling by definition looks at a system not at the aggregate level but at the level of its constituent units. Although the aggregate level could perhaps be

described with just a few equations of motion, the lower-level description involves describing the individual behavior of potentially many constituent units. Agent-based modeling provides by far a more natural description of the system, greater flexibility in representing the system, and captures emergent phenomena as a result from the interactions of individual entities.

The objectives of the conference are to:

• Present the current state of the art/science in agent-based modeling in transportation.
• Provide the lessons learned from the current research efforts in this field.
• Define where the future lies in this type of modeling effort and what steps and research agenda need to be taken to ensure its success.

The conference is tentatively scheduled for October 1-3, 2013, at the Inn of Virginia Tech in Blacksburg, Virginia. The conference chairmen are Antoine G. Hobeika and Hesham Rakha, both from Virginia Tech. The organizing committee will include one faculty member from each of the MAUTC schools, with additional invited faculty from outside the region and representatives from private industry.

Workforce Development/Student Support

Twenty proposals to support students involved in research were reviewed in June. Eight doctoral students and one master's student were funded to conduct research. White papers and/or research reports will be submitted by each student at the conclusion of their funding. The following students will receive funding:

- Sai Zhang is a doctoral student in industrial engineering at Penn State. She will be conducting research in *Dynamic and Spatial Economic Impacts of Shale Gas Play on Sector Development and Transportation Network Flows.*

- Jonathan McCoy is a master's student in transportation at Morgan State University. He will be part of a research team that will develop new tools to facilitate a better understanding of the human factors involved in the display of DMS messages for traffic and incident management, traveler information, and emergency operations.

- Mercedeh TariVerdi, a Ph.D. student in civil engineering at the University of Maryland, will develop optimization-based strategies for real-time deployment of international, federal, state, and/or local urban search and rescue (USAR) teams that build on region-wide damage assessment capabilities and survival probability estimation techniques. This work will support the mobilization of USAR teams by directing crucial assets to sites within the impact area, where the most good can be done in the first days of the emergency period. This work will have wider applicability, such as in routing and scheduling cargo or a maintenance workforce to geographically disparate locations over a transportation network in which real-time information is received and dynamically arising demand is revealed.

- Andrea Hamre is a doctoral student in civil engineering at Virginia Tech. Ms. Hamre will be conducting research that will help to increase understanding of the variability of daily and weekly travel behavior that may aid in the design and implementation of targeted policies and programs aimed at reducing driving.

- Wenjing Xue, a Ph.D. student in civil engineering at Virginia Tech, is furthering her research begun in *Integrated Infrastructure Asset Monitoring, Assessment and Management,* a collaborative project with the University of Virginia's Center for Transportation Studies and the

Virginia Transportation Research Council. Ms. Xue's objective is to build up an integrated transportation monitoring system for both the pavement and the traffic. The system will be capable of collecting the information of passing vehicles, serving as a weigh-in-motion system, and monitoring and collecting the mechanical response of the pavement. The continuous or more frequent monitoring of pavement deterioration could decrease pavement condition surveying and maintenance costs.

- T. H. Kim is a doctoral student in civil engineering at Virginia Tech. Mr. Kim will be working on *Traffic Signal Optimization at Railroad Grade Crossings*. The optimization of traffic signals at railroad grade crossings would promote grade crossing safety and could reduce traffic congestion and optimize traffic operations.

- Jaehyun So, a Ph.D. student in civil engineering at the University of Virginia, is working on a project that will develop a safety evaluation module that will properly model lane-change behavior. The new module will help enhance existing microscopic simulation models such as VISSIM, AIMSUN, and PARAMICS.

- Changiu Lee is a doctoral student in civil engineering at the University of Virginia. Mr. Lee will be conducting research to recommend a method to prioritize maintenance/replacement needs associated with the ITS infrastructure. This will be a two-step process in which the goals are to identify relevant projects for funding and prioritization. Research will focus on (1) establishing whether a technology should be kept and maintained, replaced, or removed from the system; and (2) developing a method for ranking and prioritizing approved projects. If a device is to be maintained or replaced, the questions of whether the technology is likely to be obsolete during the next device life cycle, and how that might affect the maintenance decision, will also be considered.

Base Funds

Each of the Center universities has begun soliciting proposals and working with its respective departments of transportation to select projects. Faculty are also reaching out to others within the Center to find common interests for future collaborative proposals.

The University of Maryland has selected six research projects:

- Robust Evacuation Planning with Optimal Shelter Location and Sizing, Elise-Miller Hooks
- Magnetic Signature Processing for Anonymous Vehicle Identification, Ali Haghani
- Exploring the Linkages among Urban Form, Travel Behavior, and Public Health with Person-level Data from Smart Phone Applications, Lei Zhang
- Dynamic Discrete Choice Model for Railway Ticket Cancellation and Exchange Behavior, Cinzia Cirillo
- Integration of Multi-modal Public Transportation Systems, Paul Schonfeld

Two research projects have begun at Penn State:

- Optimal Bridge Retrofit Strategy to Enhance Disaster Resilience of Highway Transportation Systems, Swagata Basu
- Nondestructive Evaluation of Warm Mix Asphalt through Resonant Column Testing, Mansour Solaimanian

West Virginia University has met with officials from the West Virginia Department of Transportation (WVDOT) to discuss their needs and interest in participating in the MAUTC grant. Their specific and immediate needs and priorities have been identified and researchers are developing specific proposals for Highway Safety, Congestion and Transportation Operations.

The research will not only impact our undergraduate and graduate students, but the efficiency of the WVU campus and national transportation operations.

PRODUCTS

Research is just getting underway, so there are no products at this time. The research projects are approximately 18 months in duration. Researchers will be submitting interim reports approximately mid-way through their research projects.

PARTICIPANTS AND COLLABORATORS

MAUTC is forging a strong relationship with the state departments of transportation within the region. Representatives from the Pennsylvania Department of Transportation (PennDOT), Maryland State Highway Administration (MSHA), Virginia Department of Transportation (VDOT)/Virginia Center for Transportation Innovation and Research (VCTIR) and West Virginia Department of Transportation are on the committee to review and select pooled projects for funding.

WVU is working with the EdVenture Group in Morgantown, West Virginia, in preparing workforce development proposals. These have been supported by the Statler College of Engineering and Mineral Resources and the WVDOT. WVU is also partnering with the WVU Transportation Department to identify needs for the city of Morgantown as well as the WVU campus community in the area of personal rapid transit in regards to efficiency and safety. Topics discussed will have an immediate impact locally but will be relevant to future personal transit systems.

IMPACT

There is a great deal of competition for top-notch graduate engineering students. The UTC funding is one tool that enhances our ability to recruit and retain these students. The UTC program also helps in the recruitment of new faculty.

CHANGES/PROBLEMS

Changes to the MAUTC program are not anticipated at this date. Each of the universities in the Center is making progress in identifying stakeholders and selecting projects to fund.

Subcontracts have been finalized with Morgan State University, University of Maryland, and University of Virginia. Subcontracts with Virginia Tech and West Virginia University are still in negotiation, but are expected to be fully executed shortly. No additional action is required.